



## Video analysis of throwing techniques in Collegiate Shot-Put athletes: A visual exploration of throwing styles and performance factors



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**Abstract:** The present study delves into the realm of collegiate shot-put athletes' throwing techniques, aiming to undertake a comprehensive comparative video analysis of various throwing styles. The primary objective is to visually explore these athletes' diverse throwing techniques and shed light on the critical performance factors associated with each style. By employing video analysis tools and techniques, this research intends to provide a detailed examination of the biomechanical nuances and body movements in different throwing methods. Through an extensive collection of video footage featuring collegiate shot-put athletes, the study will meticulously dissect and compare the variations in throwing techniques. The aim is to analyse the different types of throwing techniques used and the technique that produces the best result by collegiate shot-put athletes in and around Bangalore. 220 shot-put athletes of age group between 18-25 years, representing colleges from different Universities were approached to analyse their shot-put throwing technique with two high-definition cameras and analysed using Kinovea software. The mean rank for velocity was higher in the glide technique for both male and female athletes compared to the rotational technique. Male athletes with higher BMI used rotational technique in comparison to athletes with lower BMI, in female athletes with higher BMI used glide technique in comparison to athletes with lower BMI (p=0.0001). Based on the results obtained from our study, the glide technique was the most prevalent technique used by collegiate athletes. The gliding technique showed better throwing distance than the rotational technique. The findings of this study hold the potential to offer valuable insights to coaches, athletes, and researchers in the field of shot-put training and sports biomechanics. The comparative video analysis approach provides a unique visual perspective that supplements the existing body of knowledge concerning shot put techniques.

### Introduction

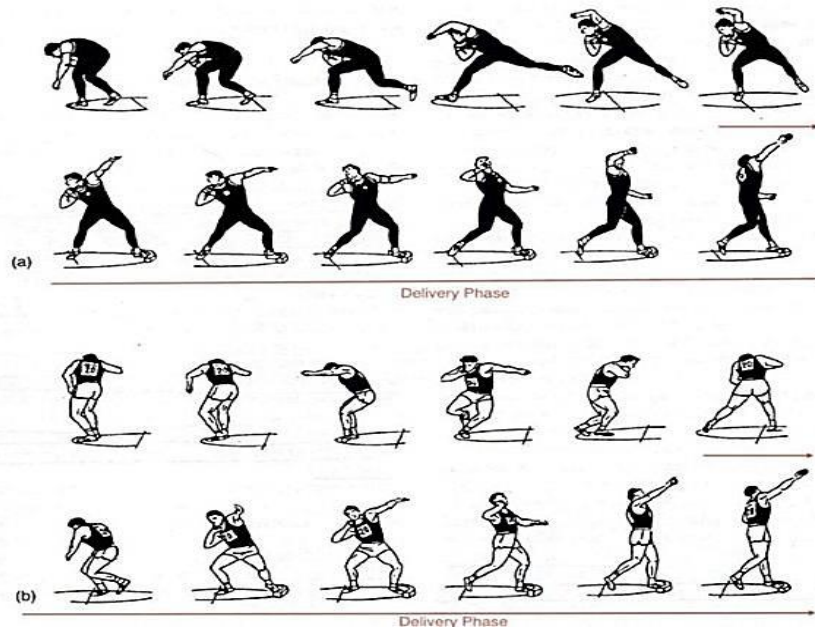
In Over the course of time, shot put athletes have experimented with several throwing techniques, including the glide, rotational, leg reverse, and shuffle approaches. The glide technique emerged in the 1950s and enjoyed

prominence for an extended period. This method involves linear propulsion from the back to the front of the circle while facing away from the designated sector. Subsequently, athletes pivot their body towards the throwing area, affecting the shot put for maximal



distance. In contrast, the rotational style gained popularity in the 1970s and remains prevalent. Leveraging video motion analysis and extracting valuable insights from recorded footage becomes possible (Gorontalo, 2022). This technique facilitates the examination, calculation of speed and acceleration, and task performance analysis, particularly within the context of

by-frame basis. In physiotherapy and rehabilitation, the software aids in analysing lower extremity movement by utilizing tools for angle measurement and path tracking. Its high validity and reliability, demonstrated by an ICC value of 0.997 and a Kappa index exceeding 0.80, establish Kinovea as a dependable resource for researchers, both within and across studies (Abdelkader



**Figure 1a. Glide Technique, 1b. Rotational or Spine Technique (Arrhenius, 2014)**

sports. Typically employing high-definition cameras and specialized software enabling frame-by-frame playback, motion analysis has evolved from its initial focus on kinematics to encompass a broader range of phenomena exhibiting visible changes. In sports, video analysis proves indispensable for achieving a competitive edge. Benefits encompass instantaneous video replay, improved training methods, opponent scouting, injury prevention, and game analysis. Although previously limited to elite teams, the ubiquity of low-budget cameras and smartphones has democratized access to such tools, benefiting coaches across all levels and sports (Zaras et al., 2021). The inherent advantage of video analysis in training lies in its ability to provide swift feedback to athletes. Coaches can promptly identify and rectify faults by leveraging video technology while athletes visually comprehend their actions, facilitating more effective learning.

Particularly in contexts where practice time is a precious resource, the expeditious delivery of feedback is crucial for addressing mistakes and honing skills. Kinovea software, a freely available 2D video analysis tool, finds utility in both sports and clinical applications. Downloadable from the internet in various versions, Kinovea empowers users to manipulate time-based parameters and measure angles and distances on a frame-

et al., 2020; Van Biesen et al., 2018).

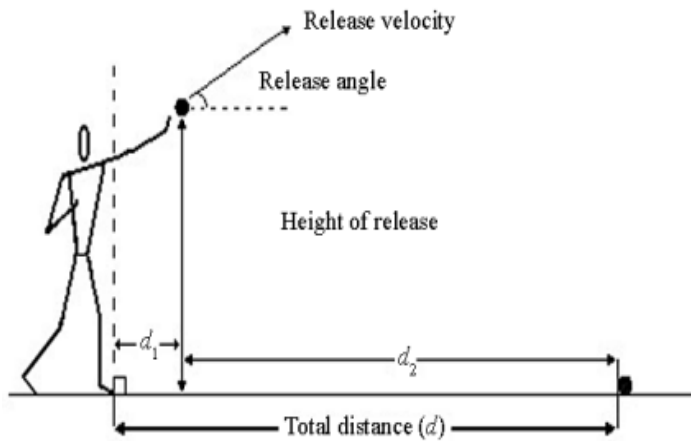
#### **The need for these studies**

A thorough study is necessary to comprehend the intricacies of each throwing technique as shot put athletes utilize various throwing methods. Identifying important biomechanical components that lead to the best shot-put performance is possible by analysing these strategies using video motion analysis. Shot put distances are actively sought after by athletes, coaches, and researchers. The study can determine which throwing approaches are most helpful for attaining better performance results by analysing various throwing styles utilizing video analysis. The goal of coaching is to provide players with specific feedback so they can improve their skills. Video analysis is crucial in this process because it enables coaches to provide athletes with evidence-based advice that corrects certain technical issues and improves their overall performance. Given the prevalence of cell phones and the accessibility of user-friendly video editing tools (Irawan and Prastiwi, 2022).

The primary objective is to thoroughly compare different shot-put throwing methods, such as the glide and rotational methods, by analysing video footage of athletes. This goal entails looking at how factors like throwing style affect shot put throwing distance.

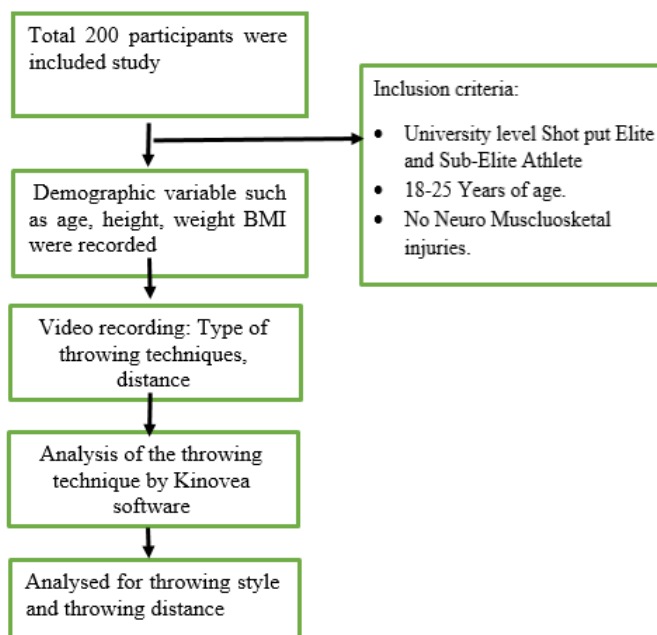
## Materials and Methods

In all, 200 athletes took part in this investigation which was the sample size calculated for the study. The



**Figure 2. Graphical representation of release parameters contributing to the total distance of the throw**

chosen individuals were between the ages of 18 and 25, and their participation was only permitted after receiving the necessary ethical approvals (IEC/IRB/DSI/MPRT/2022/007). The athletes were given in-depth explanations regarding the goal of the study and the various procedural steps. All subjects gave their full informed consent before baseline data, including demographic details and anthropometric measures, were painstakingly gathered. Participants contributed by providing their demographic information on a self-reporting evaluation form. Shot-put competitors from both sexes were included in the study.



**Figure 3. Study flow chart**

The Dayananda Sagar University pitch, Kanteerava Stadium, Kithur Rani Chennamma pitch, and Nagarjuna

College of Engineering's SJC Institute Ground are athletic sites where the study was carried out. Two cameras, one with a 55-250mm lens on each, were used to record the throwing patterns. A 10-metre separation separated the two cameras, one of which was set strategically at the front of the shot-put circle and the other at the back. This layout made it easier to examine the athletes' throwing techniques in depth. Each throwing attempt was timed for an average of about 7 seconds, starting when the athlete received the shot from the referee and ending until the shot made contact with the ground. For each camera, a sizable dataset of about 100 minutes in length was gathered, offering a solid basis for further investigation. The Kinovea software, a popular tool for 2D video analysis, was utilised to analyse the recorded films. With the use of this programme, the throwing mechanics of the athletes could be carefully examined, allowing for the extraction of insightful data from the recorded throws (Hariono et al., 2021). The methodological framework employed in this study rigorously adhered to ethical standards and rigorous data collection techniques.



**Figure 4. Shotput Throwing Position**

## Results

The study involved the recruitment of 200 athletes for the purpose of analyzing various throwing techniques in shot-put. The overall mean age of the participants was found to be  $20.53 \pm 1.75$  years. Among these, the mean age for athletes utilizing the glide technique was  $20.57 \pm 1.76$  years, while those employing the rotational technique had a mean age of  $20.05 \pm 1.51$  years. When categorizing the participants into specific age groups, the results indicated the following proportions: The age group of 18-19 years constituted a total mean percentage



of 32.44%. Within this age group, 31.55% of participants utilized the glide technique, and 42.11% opted for the rotational technique. The age group of 20-21 years accounted for a total mean percentage of 40.00%. Among these participants, 39.81% employed the glide technique, and 42.11% favoured the rotational technique. In the age group of 22-23 years, the total mean percentage was 20.00%. Within this category, 20.87% of athletes utilized the glide technique, while 10.53% opted for the rotational technique. Lastly, the age group of 24 years comprised a total mean percentage of 7.56%. Among these participants, 7.77% used the glide technique and 5.26% preferred the rotational technique.

equivalent to a mean percentage of 10.53%, chose to use the rotational technique. This gender-based breakdown of participants allows for a comprehensive understanding of the prevalence of specific throwing techniques within the study, shedding light on the differential utilization of these techniques between male and female shot-put athletes. A comparative analysis was conducted using the Mann-Whitney U test to assess the distance parameter, differentiating between male and female athletes employing both glide and rotational techniques. The overall mean distance covered using the glide technique was calculated at  $7.16 \pm 1.80$  units, whereas the rotational technique resulted in a greater mean distance of

**Table 1. Comparison of Technique (Glide and Rotational) according to age**

Age groups	Glide technique	%	Rotational technique	%	Total	%
<b>18-19yrs</b>	65	31.55	8	42.11	73	32.44
<b>20-21yrs</b>	82	39.81	8	42.11	90	40.00
<b>22-23yrs</b>	43	20.87	2	10.53	45	20.00
<b>24yrs</b>	16	7.77	1	5.26	17	7.56
<b>Mean age</b>	20.57		20.05		20.53	
<b>SD age</b>	1.76		1.51		1.75	
<b>Total</b>	181	100.00	19	100.00	200	100.00

**Table 2. Comparison of techniques (Glide and Rotational) with distance (in meters) in total, male and females by Mann Whitney U test**

Samples	Technique	Mean	SD	Mean rank	U-value	Z-value	P-value
<b>Total</b>	Glide technique	7.16	1.80	107.84	894.50	-3.9116	0.0001*
	Rotational technique	9.26	2.87	168.92			
<b>Male</b>	Glide technique	9.11	2.24	36.31	442.50	0.2156	0.8293
	Rotational technique	9.50	2.92	35.03			
<b>Female</b>	Glide technique	6.46	0.89	77.21	107.50	-0.7022	0.4826
	Rotational technique	7.21	1.55	99.75			

The study comprised a total of 225 participants, with 71 males representing a mean percentage of 31.56% of the total sample. Among these male participants, 54 individuals, equivalent to a mean percentage of 26.21%, employed the glide technique, while 17 individuals, constituting a mean percentage of 89.47%, utilized the rotational technique. In contrast, the study included 154 female participants, accounting for the majority, with a mean percentage of 68.44% of the total sample. Within this group of female participants, 152 individuals, representing a mean percentage of 73.79%, opted for the glide technique. A smaller subset of 2 individuals,

$9.26 \pm 2.87$  units.

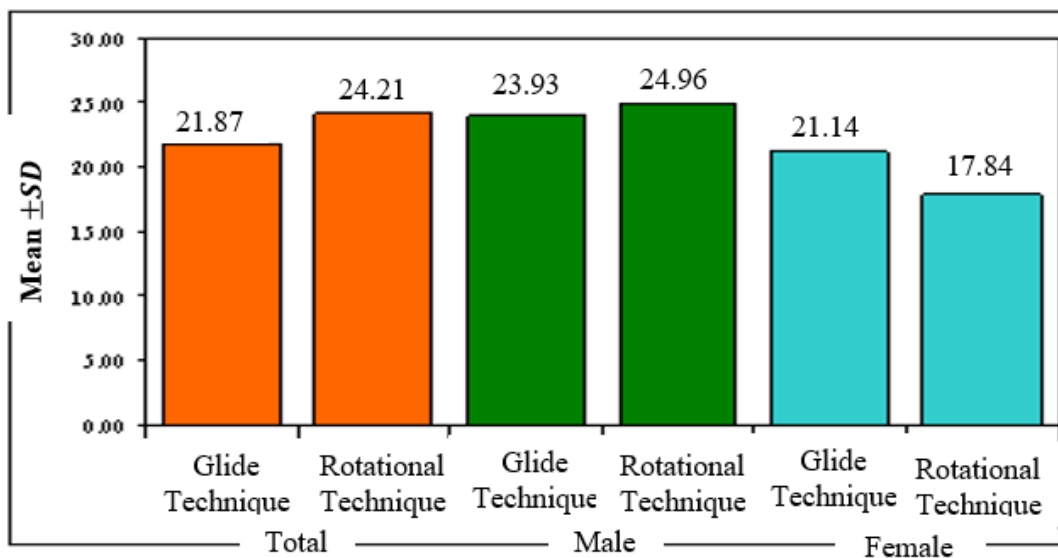
Among male athletes, the mean distance covered using the glide technique was  $9.11 \pm 2.24$  units, while the rotational technique yielded a slightly higher mean distance of  $9.50 \pm 2.92$  units. In contrast, the glide technique led to a mean distance of  $6.46 \pm 0.89$  units among female athletes, while the rotational technique resulted in a mean distance of  $7.21 \pm 1.55$  units. The analysis revealed a statistically significant difference, with a p-value of 0.0001, between the total distances achieved using the rotational and glide techniques. Consequently, the mean rank for the total distance

covered using the glide technique was 107.84, whereas, for the rotational technique, it was 168.92. When considering male athletes, the mean rank for the distance covered using the glide technique was 36.31, and for the rotational technique, it was 35.03. Among female athletes, the mean rank for the distance covered using the glide technique was 77.21, while for the rotational technique, it was 99.75.

throwing techniques, the results reveal variations across different age categories, suggesting a notable preference for the rotational technique among athletes in this age group, potentially due to factors such as contemporary coaching practices or the influence of successful athletes using this technique (Chen et al., 2022; Salinero and Coso, 2022). The nearly equal distribution in technique preference indicates that both techniques are popular

**Table 3. Comparison of Glide and Rotational) with BMI (Kg/m<sup>2</sup>) in total, male and females by Mann Whitney U test**

Samples	Technique	Mean	SD	Mean rank	U-value	Z-value	P-value
<b>Total</b>	Glide technique	21.87	3.28	110.11	1362.50	-2.1878	0.0287*
	Rotational technique	24.21	4.86	144.29			
<b>Male</b>	Glide technique	23.93	4.51	34.80	394.00	-0.8691	0.3848
	Rotational technique	24.96	4.56	39.82			
<b>Female</b>	Glide technique	21.14	2.33	78.48	2.50	2.3778	0.0174*
	Rotational technique	17.84	0.93	2.75			



Comparison of techniques (Glide and Rotational) with BMI (kg/m<sup>2</sup>) in total, male and females.

**Figure 5. Comparison of Shotput Technique with BMI**

## Discussion

The findings of this study provide valuable insights into the relationship between age groups and the preference for specific throwing techniques in shot-put, indicating a relatively young cohort of athletes involved in shot-put. Interestingly, when examining the relationship between age groups and the choice of

among athletes in this age range. However, the age group of 22-23 years exhibited a lower total mean percentage of 20.00%. Among these participants, 20.87% used the glide technique, whereas only 10.53% chose the rotational technique. The study results suggest a dynamic relationship between age groups and the preference for different shot-put throwing techniques. While the rotational technique appears popular among younger

athletes, its prevalence diminishes in some older age groups. These findings provide valuable context for understanding the evolution of technique preferences within the shot-put athletic community, and further research or longitudinal studies could explore the underlying factors influencing these trends in greater detail. (Mastalerz and Sadowski, 2022; Salinero and Coso, 2022; Schofield et al., 2019). The gender-based breakdown of participants in the study reveals intriguing insights into the utilization of specific shot-put throwing techniques among male and female athletes. Among the male participants, 31.56% had a noticeable preference for the rotational technique. A significant majority of males, 89.47%, chose this technique, while a smaller proportion of 26.21% used the glide technique. This emphasizes the popularity of the rotational technique among male shot-put athletes in the study. In contrast, among the female participants, 68.44%, the glide technique was the more prevalent choice. A vast majority of female athletes of 73.79% opted for the glide technique, while only 10.53% utilized the rotational technique. This indicates a clear gender-based disparity in technique preference, with females demonstrating a stronger inclination toward the glide technique (Judge et al., 2021; *View of Predictive Value of Kinematic Indicators for Shot Put Result and Selection of Novice Athletes*, n.d.) The observed differences in technique preferences between genders can be attributed to various factors, including physiological differences, coaching methodologies, and personal preferences. The greater utilization of the rotational technique among males could be influenced by its potential advantages in terms of power generation and competitive success. On the other hand, the prevalence of the glide technique among females might stem from its emphasis on finesse and technique, which may be favoured in certain training environments (Arrieta et al., 2016; Brustio et al., 2019; Schleichardt et al., 2019). The analysis of distance covered by different throwing techniques among male and female athletes offers valuable insights into the relationship between technique selection and performance outcomes. The data indicates a marginal difference in mean distances achieved using the glide and rotational techniques among male athletes. The glide technique resulted in a mean distance of  $9.11 \pm 2.24$  units, while the rotational technique exhibited a slightly higher mean distance of  $9.50 \pm 2.92$  units. This slight difference is consistent with the notion that the rotational technique can offer a competitive advantage due to its potential for generating greater power and momentum (Antropométricas et al., 2023; Kardor et al., 2023; Pavlović et al., 2020). In the case of female athletes, a

similar trend is observed. The glide technique yielded a mean distance of  $6.46 \pm 0.89$  units, while the rotational technique led to a mean distance of  $7.21 \pm 1.55$  units. Again, the rotational technique showcases a slightly higher mean distance, aligning with the general understanding of its potential for achieving greater distance due to its mechanics (Krzysztofik et al., 2021; Wan et al., 2020). The statistically significant difference emphasizes the impact of technique selection on total distances achieved. This underscores the importance of choosing an appropriate throwing technique based on an athlete's individual strengths and physical attributes. The considerable difference in mean ranks further supports this observation. The mean rank for the total distance covered using the glide technique was 107.84, whereas, for the rotational technique, it was notably higher at 168.92. This disparity highlights the potential advantages of the rotational technique in generating longer shot-put distances (Zaras et al., 2019).

### Conclusion

Our comprehensive comparative video analysis of collegiate shot-put athletes' throwing techniques has revealed that the glide technique is the prevailing choice, showing superior throwing distance compared to the rotational technique. We've also identified a correlation between athlete BMI and technique preference. This study offers valuable insights for coaches, athletes, and researchers, augmenting shot-put training strategies and performance in the competitive arena.

### Conflict of Interest

The authors declare that there are no conflicts of interest to disclose with regard to this manuscript. This research was conducted with full transparency, and no competing financial or non-financial interests have influenced the study design, data collection, analysis, or the interpretation of results. The publication of this work aims solely to contribute valuable insights to the scientific community in the field of shot-put technique analysis.

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### Ethical Clearance

We obtained approval from the Institutional Review board of Dayanand Sagar University, Bangalore, India (IEC/IRB/DSI/MPRT/2022/007).

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